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WATERPROOFING AND MILDEWPROOFING OF COTTON DUCK

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ONLY unbleached, unsized, closely woven duck should be used for farm purposes, and, unless the canvas is to be subjected to a proofing treatment, it is recommended that only mineral-dyed khaki be bought for out-of-door use.

It is more economical to buy a good grade of duck, even at a decidedly higher first cost, than a cheap duck of light weight and poor construction.

Mildew is the chief cause for the deterioration of cotton duck. Untreated duck always mildews in warm weather if stored wet or even slightly damp. To prevent mildewing, the canvas should be thoroughly dried in the open air before it is folded and stored.

Any treatment which decreases the absorption of water by canvas increases its mildew resistance. In humid climates or seasons, or under conditions of service where the canvas remains wet or moist for several days at a time, a treatment which will decrease water absorption and, in consequence, susceptibility to mildew, should be applied.

Satisfactory results for increasing the serviceability of cotton duck have been obtained with the formulas given in this bulletin. One coat applied to one side of the canvas usually is sufficient.

WATERPROOFING AND MILDEWPROOFING OF COTTON DUCK.

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USE OF COTTON DUCK.

COTTON DUCK, otherwise known as canvas, is used extensively for the protection of machinery, sacked grain, shocks, stacks and ricks, for wagon and truck covers, for awnings and temporary shelters, for horse covers, and for catching grain which falls to the ground during thrashing. Undoubtedly it would be used to a greater extent if it fulfilled more effectively these various purposes and if it retained its serviceability for a longer period than it ordinarily does.

This bulletin tells how to select and care for duck or canvas on the farm and describes simple methods for prolonging its period of serviceability by the application of waterproofing and mildewproofing treatments.

CLASSES OF COTTON DUCK.

Two general classes of cotton duck are known to the cotton-goods trade. They are "numbered duck" and "ounce duck."

"Numbered ducks" are made of multiple-ply yarns in both the warp and filling directions. The numbers run down, and the weights up, from 12 to 0 (or more ciphers), with a difference in weight between the consecutive numbers of 1 ounce per linear yard 22 inches wide. The canvas can be bought in widths of from 22 to 144 inches. Number 12 duck, which is the lightest of this class, weighs 7 ounces per linear yard 22 inches wide, or about 11.5 ounces per square yard. Number 00 duck, the heaviest commonly used, weighs 20 ounces per linear yard 22 inches wide, or about 32.7 ounces per square yard.

"Ounce ducks" are usually from 28½ to 30 inches wide and weigh from 6 to 15 ounces per linear yard. There are three grades or qualities of ounce ducks:

(1) *United States standard Army duck.*—This is the best grade of light and medium-weight duck on the market. It is made of multiple-

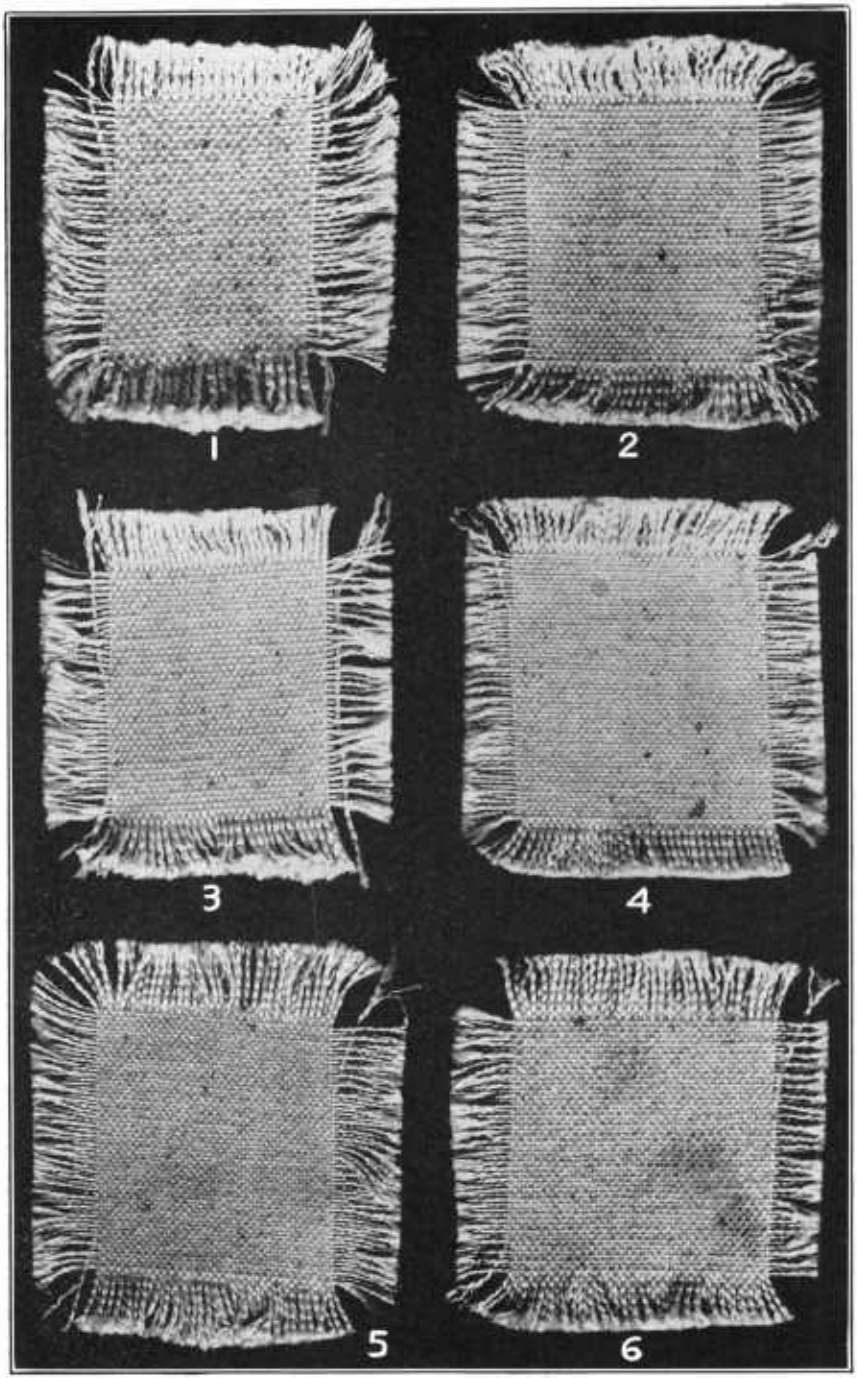

FIG. 1.—No. 8 duck.
FIG. 2.—15-ounce U. S. standard Army duck.
FIG. 3.—No. 10 duck.
FIG. 4.—12-ounce standard Army duck.
FIG. 5.—No. 12 duck.
FIG. 6.—10-ounce U. S. standard Army duck.

ply yarns both in the warp and filling directions, and is not bleached, loaded, or sized (figs. 2, 4, 6, and 13).

(2) *Double-filled duck.*—The warp consists of single-ply yarns and the filling of multiple-ply yarns (figs. 7, 9, 11, and 14).

(3) *Single-filled duck.*—Both the warp and filling are made of single-ply yarns. This is the cheapest and poorest grade of duck on the market (figs. 8, 10, and 15).

In both the double-filled and single-filled ducks the filling yarns are much heavier than the warp yarns. In order to make a canvas of more uniform appearance, therefore, the warp yarns are usually woven in pairs, resulting in a loosely woven duck which has little water resistance and can not be as thoroughly waterproofed as the multiple-ply ducks.

Double-filled and single-filled ducks are the kinds most commonly used for awnings. As a rule they have been bleached and are also usually heavily sized to give weight to the material. They are not recommended for out-of-door service.

SELECTION OF COTTON DUCK FOR FARM USE.

For farm purposes only unbleached, unsized, closely woven duck should be used. It should not be too stiff, however, nor so closely woven that it has no flexibility when wet and cold, in which case it has a tendency to crack when creased or folded. Furthermore, stiff canvas is very difficult to handle, and, when used as a cover, does not shape itself properly to objects, as a result of which it does not give them adequate protection. For horse covers a moderately stiff canvas is preferable, as it does not lie close to the body of the animal and does not cause sweating as readily as the more flexible material.

Large wagon covers or paulins.—These should be made of No. 8 duck, which weighs about 18 ounces per square yard, or of 15-ounce United States standard Army duck, weighing about 18.9 ounces per square yard (figs. 1 and 2).

Small wagon and machine covers or tents.—Either No. 10 or 12-ounce United States standard Army duck is suitable for this purpose, as both have sufficient body without being too stiff when wet. No. 10 duck weighs about 14.7 ounces and 12-ounce United States standard Army duck about 15.2 ounces per square yard (figs. 3 and 4).

Shock and other small covers.—No. 12 duck, weighing about 11.5 ounces per square yard, or 10-ounce United States standard Army duck, weighing 12.6 ounces per square yard, is satisfactory for this purpose (figs. 5 and 6).

It is more economical to buy a good grade of duck, even at a decidedly higher first cost, than a cheap duck which is of light weight and poorly constructed and which will not prove serviceable.

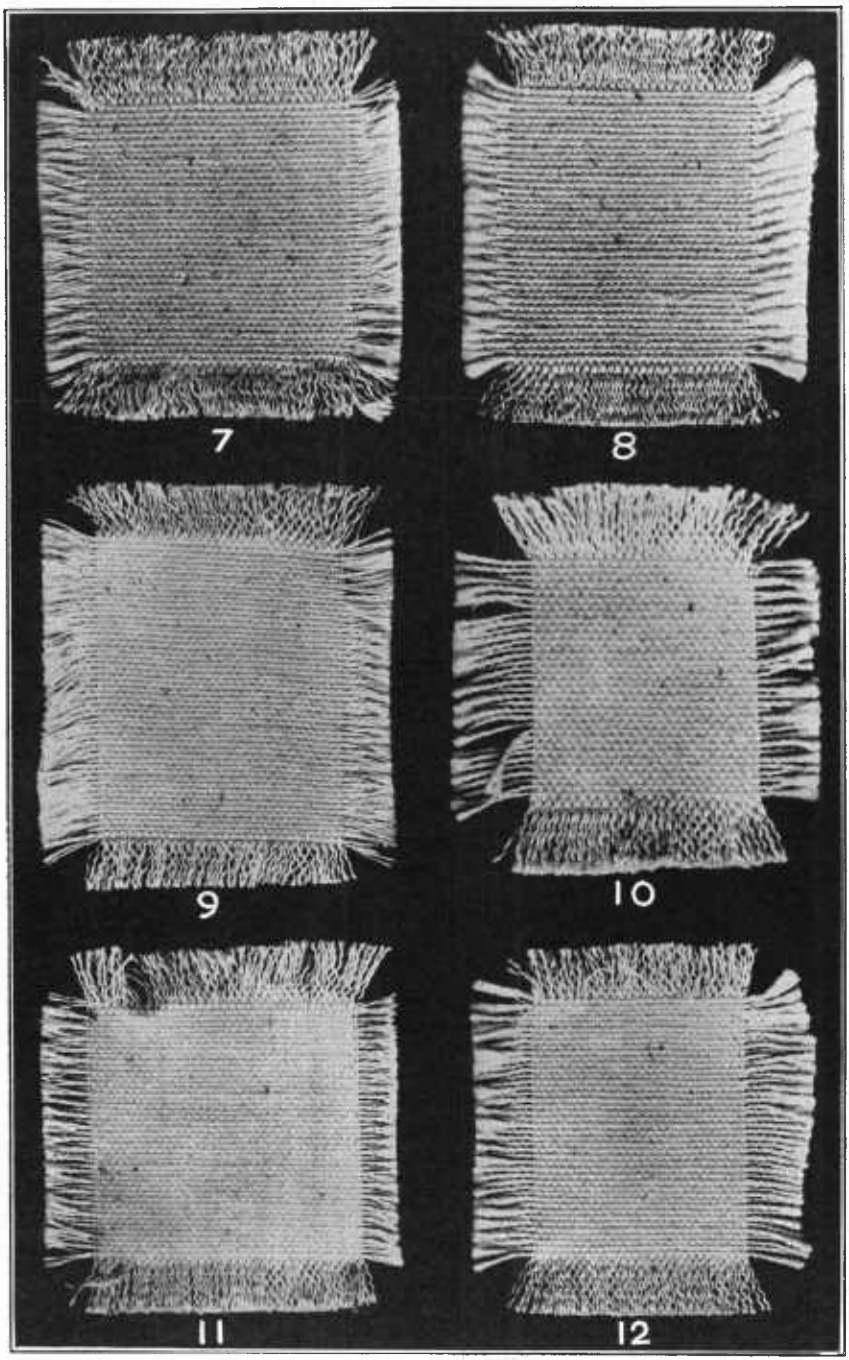

FIG. 7.—15-ounce double filled duck.
FIG. 8.—15-ounce single filled duck.
FIG. 9.—12-ounce double filled duck.
FIG. 10.—12-ounce single filled duck.
FIG. 11.—10-ounce double filled duck.
FIG. 12.—10-ounce single filled duck.

Duck which when held up to the light shows numerous pinholes or thin places does not make good covers, although a few small pinholes may be permitted. It should be made from multiple-ply yarn and the weave should be medium hard. The ply of the yarns can be determined by untwisting them and counting the number of small threads into which they separate. To ascertain the closeness of the weave, the duck may be unraveled on two adjacent sides and the number of ends of yarn in a measured inch on each side counted. Warp threads run in the long direction of the goods; filling threads run across the goods.

General observation has shown that cotton duck which has been dyed a khaki color with mineral dyes is more water resistant than the white untreated duck. It is also quite mildew resistant and remains so for a long time if the dyeing process has been properly conducted. Unless the canvas is to be subjected to a proofing treatment, it is recommended that only mineral-dyed khaki canvas be bought for severe service. A khaki color may be obtained also by the use of organic dyes, but the mineral-dyed fabric is much to be preferred. The following very simple test will suffice to determine whether the fabric has been dyed with organic dyes or with mineral dyes:

Burn a piece of the duck until no carbon is left in the ash. If mineral dyes have been employed, an appreciable amount of ash, colored from buff to dark brown, will be present, whereas if organic dyes have been used, only a small amount of a white to gray ash will remain.

CARE OF COTTON DUCK.

Because of the greatly increased world consumption of cotton and the enormous crop losses caused by the boll weevil during the past few years, the present demand for high-grade cotton is barely met by the supply. As a result the cost of cotton goods, and particularly that of heavy ducks made from the better grades of cotton, is very high. It is, then, a matter of both national and personal economy to conserve the supply of cotton, and by proper care to make cotton duck last as long as possible.

The deterioration of cotton duck is due to a number of causes, the chief one being mildew, which usually appears when the canvas remains damp for several days in warm weather. Mildew is readily recognized by the appearance on the canvas of white, black, yellow, pink, or green spots, varying in size from that of a pinhead to that of a 5-cent piece. Canvas may be injured also by bacterial action, which produces no marked change in the color but weakens the entire fabric. This occurs when the canvas has lain for some time in contact with the ground or a damp floor. In addition canvas may

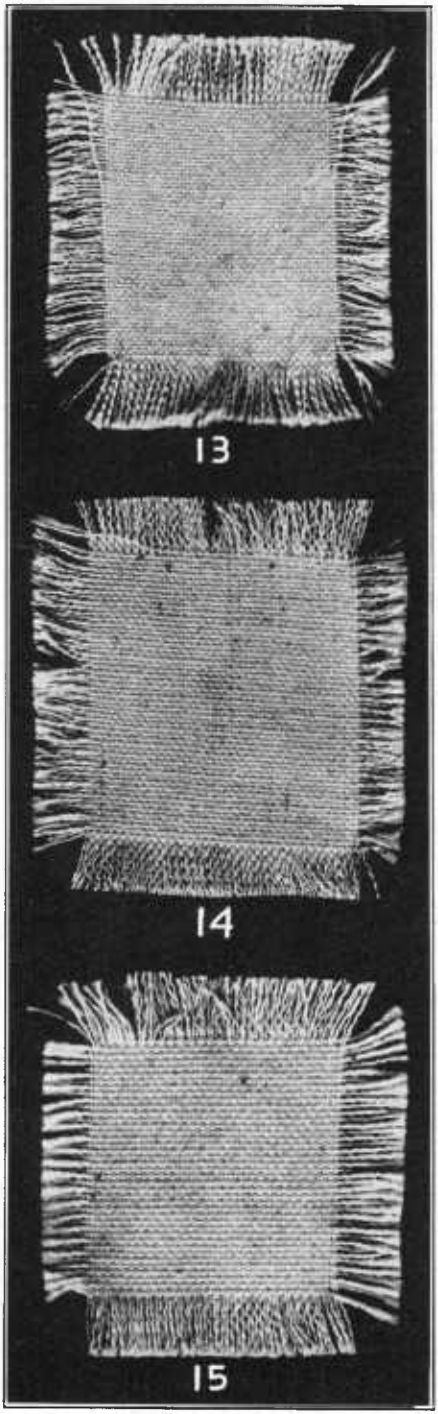

FIG. 13.—8-ounce U. S. standard Army duck.
FIG. 14.—8-ounce double filled duck.
FIG. 15.—8-ounce single filled duck.

be weakened by the chemical action of materials in it or by the action of air and moisture alone under the influence of sunlight.

White untreated cotton duck mildews very quickly under certain conditions, such as warmth, absence of light, and a moist atmosphere. Canvas which is folded and stored wet or even slightly damp usually is more or less mildewed when taken out, especially if it has been put in a rather warm, dark place. Such canvas is much weakened and leaks in the mildewed places, so that if not totally useless when first taken out it soon becomes so in service and must be replaced.

Canvas which has become wet or even damp should be dried as soon as possible by being spread out over a wagon or hung over a wooden fence or a large pole, preferably in the sunshine, until it is thoroughly dry. If the weather is wet, it may be hung under a shed or in the barn. No canvas, bags, etc., should be folded or stored while damp. Folding of heavy canvas, especially if it has been stiffened by a waterproofing treatment or by being wet or frozen, may weaken or crack the fabric, causing it to leak. For this reason heavy canvas when not in use should hang over a beam or large horizontal pole, or should be suspended against the inside of a barn or shed rather than folded.

WATERPROOFING AND MILDEWPROOFING COTTON DUCK.

Cotton duck, or canvas, which has been given no special treatment sheds water to some extent as long as it does not mildew, especially if it is closely woven and shows but few pinholes when held up to the light. Its water resistance in the untreated condition is sufficient for awnings, pavilions, fixed wagon covers, tents, large umbrellas, or other uses where the fabric is not in a horizontal position and where it is not in contact with objects beneath it. Untreated canvas does not owe its serviceability for such purposes to the fact that it does not become wet. Except in the case of new and unbleached fabrics, where the natural oils and waxy substances of raw cotton fiber as well as oils applied to the yarn during spinning and weaving are still present, cotton fabrics have high water absorption, and canvas used for any of the purposes mentioned will be found to be soaked with water after a rain.

In general, it may be said that the danger from mildew increases with the tendency of the canvas to become wet, unless some substance which is decidedly poisonous to mildew is present. Where the wet canvas remains exposed to the light and air so that it can dry in a reasonably short time, there is little necessity for treatment to prevent mildew. In humid climates or seasons, or under conditions of service where the canvas remains wet or moist for several days at a time,

however, treatments which will decrease the rate of water absorption, at the same time decreasing the susceptibility to mildew, should be applied. Another reason for applying waterproofing treatments is that untreated canvas brought in contact, especially moving contact, with objects beneath it does not shed water satisfactorily.

White untreated canvas remains serviceable for from one to five years, or occasionally longer, depending upon its quality, the conditions under which it is used, and the care taken to keep it from mildewing. As previously stated, canvas dyed a khaki color with mineral dyes lasts longer than white untreated canvas under the same conditions. Since it is sometimes difficult to obtain khaki-colored canvas and not always possible to exercise proper and timely care of canvas articles, treatments which will increase the serviceability of white duck are desirable. Proper treatments increase the usefulness and more than double the period of serviceability of white canvas. Treated canvas and commercial preparations for treating canvas may sometimes be obtained from tent and awning dealers, but should never be purchased without some satisfactory evidence of the merit of such treatments.

The most common of the several existing types of waterproofing processes are: (1) Those in which the water resistance is due to insoluble metallic soaps or other insoluble metallic compounds, as, for example, aluminum soap, acetate of aluminum, mineral khaki, and cuprammonium treatments; (2) those depending upon the use of paraffin or mixed waxes; (3) those depending upon the use of bituminous materials, such as asphaltum or tar; (4) those depending upon the use of linseed oil or other drying oils; (5) those where combinations of the processes of types 1, 2, 3, and 4 are used.

By some treatments, such as the cuprammonium, substances which are poisonous to mildew growth are left on the canvas. Practically complete mildew resistance may be obtained by means of the cuprammonium treatment, but this treatment and many others are not adapted to home application. Mildew resistance can be secured best in home treatments by the application of materials which are effective waterproofing agents but contain no food for the mildew organisms, or by the incorporation in the waterproofing materials of fungicides which retard decidedly the development of mildew growth. Some waterproofing treatments, particularly those in which raw drying oils or semidrying oils, such as linseed and cottonseed, are used, should be avoided, as they cause a deterioration in the strength of the fabric and also render the treated canvas liable to spontaneous combustion. It is advisable also to avoid treatments with hard paraffin wax, as they give canvas undesirable physical properties which seem to make it more, rather than less, susceptible to the action of mildew.

FORMULAS.

After thorough tests, both in the laboratory and in the field, the department has found that the following formulas, which have been developed in the course of its investigations, are very satisfactory for increasing the serviceability of cotton duck. It is believed that they will meet the requirements of the farmer and ranchman and others using canvas for outdoor purposes. These formulas are designed solely for use in waterproofing and mildewproofing treatments. While the department believes that the formulas here given do not infringe on any existing patents or pending applications for patents, it can assume no responsibility in the matter.

FORMULA 1.

	Pounds.
Amorphous mineral wax or crude petrolatum	7½
Yellow beeswax	1
Refined Bermudez Lake asphalt	1½

Solvent: 3 gallons gasoline and 2 gallons kerosene.

FORMULA 2.[1]

	Pounds.
Petroleum asphalt (medium hard) or Bermudez asphalt	6
Neutral or extracted wool grease	2½
Lead oleate, technical	1½

Solvent: 3 gallons gasoline and 2 gallons kerosene.

FORMULA 3.

	Pounds.
Amorphous mineral wax or crude petrolatum	8½
Yellow beeswax	1½

Solvent: 3 gallons gasoline and 2 gallons kerosene.

FORMULA 4.

	Pounds.
Amorphous mineral wax or crude petrolatum	6½
Yellow beeswax	1½
Lead oleate, technical	2

Solvent: 3 gallons gasoline and 2 gallons kerosene.

Applications of mixtures made by formulas 1 and 2 give the canvas a dark brownish color, while those made according to formulas 3 and 4 give it a light buff to khaki color. The first two are preferable for all purposes where a dark color is not objectionable.

The amorphous wax referred to in the formulas is a soft grease-like mineral "wax" obtained as a by-product in refining chilled cylinder-

[1] This formula was devised on July 28, 1919. Subsequent to that date, on September 30, 1919, U. S. Patent No. 1,317,469 was issued to R. R. Adams, covering the use of wool grease as an "oleaginous ingredient" of a paint, the wool grease being added for the purpose of increasing the adhesive properties, the flexibility, and the luster. Formula 2 is intended to be used for waterproofing and mildewproofing purposes, and not as a paint. It differs from a paint in its general composition and also in that when applied to one side of canvas it does not simply form a surface coating but thoroughly impregnates the fabric so that both sides are substantially alike.

oil stocks by means of centrifugal machines, and is very similar to dark petrolatum, except that it is more viscous and has a higher melting point. The substitution for it of dark or amber petrolatum will not materially change the results. Lead oleate is an insoluble metallic soap, which is added to insure waterproofness as well as mildewproofness. The kerosene is added not only to decrease the cost, but to reduce the volatility of the solvent, thus making the mixture spread better. All of these materials may be purchased, but not always from local dealers. Amorphous mineral wax or crude petrolatum (sometimes called petroleum grease) may be secured from dealers in oils and greases. The asphalts are obtainable from dealers in roofing materials. At present it probably is impossible to buy the wool grease from local dealers. This material, as well as amorphous mineral wax, however, may be ordered from wholesale dealers in oils and greases or tanners' supplies, through hardware stores, or through dealers in agricultural supplies and implements. Lead oleate, which also is not sold by small dealers, must be ordered from manufacturers of chemicals through local druggists or paint dealers, who will also supply beeswax.

MIXING THE MATERIALS.

Weigh out the solid materials in proper proportions, place them in a kettle or can, and melt slowly and carefully at as low a temperature as possible, with constant stirring. When the mixture has completely melted, *remove to a safe distance from the fire*, and pour it slowly, with constant stirring, into the proper quantity of solvent (a mixture of 3 parts by volume of gasoline and 2 parts by volume of kerosene), using 5 gallons of this solvent to 10 pounds of the mixture. This should be done with free ventilation, preferably out of doors.

In the preparation of mixtures by formulas 1 and 2 there is sometimes a separation of asphalt that does not mix uniformly with the solution upon stirring or shaking. In such cases allow the mixture to stand a day or so, with occasional stirring, before applying it to the canvas. In other cases where the material settles to the bottom of the container or thickens it will be necessary to warm the mixture just before applying it to the canvas. This must be done in the open air by *placing the open container in a tub or can of hot water.* Be sure that the container is open, and *NEVER PLACE IT OVER OR NEAR A FLAME.*

APPLICATION.

The mixture must be thoroughly stirred before and during application, in order to keep the undissolved material in suspension. These preparations may be applied to the canvas by means of a paint brush or by spraying. Wagon covers, shock covers, etc., may be treated

best by stretching the canvas against the side of a barn or attaching it to a frame and applying the material with a brush. Once the canvas is fixed in position, no more time is required to treat it than is necessary to apply a first coat of paint to a rough board siding having the same area. Much time may be saved in treating large paulins and standing tents by applying the material with a spray pump, with which a pressure of at least 50 pounds is developed. Some loss of material, however, results from this method.

The experience of the department has been that one coat applied to one side of the canvas usually is sufficient. When one coat is applied to one side, using the strength of solution as given in the formulas, there will be an increase in weight of from $3\frac{1}{2}$ to $4\frac{1}{2}$ ounces per square yard. Ten pounds of the material and 5 gallons of the solvent will treat about 40 square yards of canvas.

COST OF WATERPROOFING AND MILDEWPROOFING COTTON DUCK.

Based on the lowest prices current in Washington, D. C., in August, 1920, the cost of the materials called for in the formulas here given has been estimated to be as follows:

	Materials furnished.	
	Retail.	Wholesale.
Formula 1	$3.30	$2.80
Formula 2	2.70	2.45
Formula 3	3.80	3.10
Formula 4	4.30	3.50

This cost is calculated for about $6\frac{1}{4}$ gallons of the mixture, which would cover about 40 square yards of canvas; that is, the cost of the treatments would vary from about 7 to about 11 cents a square yard. The cost of preparing the mixture by formula 2 is reduced by about 25 cents when extracted wool grease is substituted for the neutral wool grease first specified.

The prices on which these estimates were based are as follows:

	Retail.	Wholesale.
Amorphous mineral wax or crude petrolatum (per pound)	$0.15	$0.10
Yellow beeswax (per pound)	.75	.60
Bermudez Lake asphalt (per pound)	.04	.04
Petroleum asphalt (per pound)	.02	.02
Neutral wool grease (per pound)	.25	.20
Extracted wool grease (per pound)	.15	.10
Lead oleate, technical (per pound)	.40	.30
Gasoline (per gallon)	.31	.31
Kerosene (per gallon)	.22	.22

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